November 1971

Brief 71-10440

NASA TECH BRIEF

Ames Research Center

Digital Aspect Clock

The problem:

To design an adaptive system which provides accurate time-sector division of a spin-stabilized satellite, so that the integral times for viewing physical

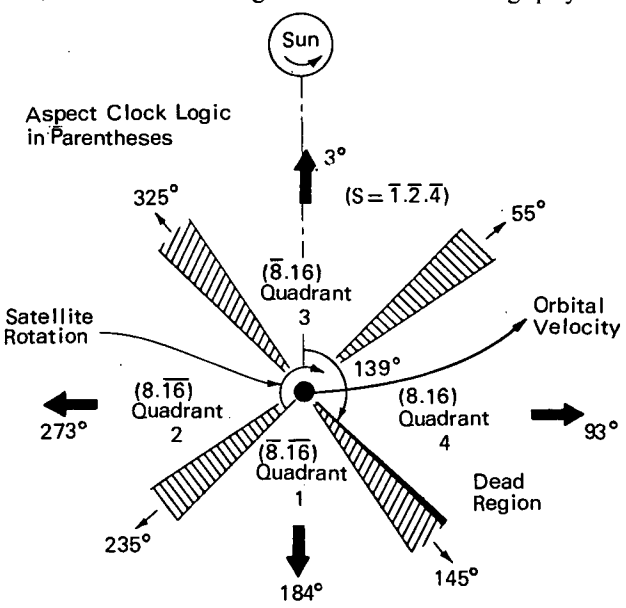

Figure 1. Geometric Relationships

phenomena from various directions by a single detector will be exactly equal and the mean angles of viewing can be accurately determined.

The solution:

An accurate digital clock that can be precisely set and reset by pulses from a solar sensor, combined with a logic system which delivers data in a form that permits accurate relation of a physical phenomenon to integration time and to the angular position of the detector with respect to the sun.

How it's done:

As indicated in Figure 2, a suitable frequency source, f, feeds two cascaded ripple-through counters, M and N, via a gate which is controlled by a suitably-shaped pulse generated by an optical aspect (OA) sensor located on the perimeter of the spinning satellite. Counter-M consists of m binaries; hence, the output frequency is f/2m. In the time period T between the cessation of one sun pulse and the commencement of the next, n pulses are counted by counter-N, where n is given by Tf/2m + R, where R, the remainder, is less than 2m. That is, n is an adaptive measure of the spin period of the satellite.

At that instant when the OA pulse closes the input gate to counter-M, the content of counter-N is parallel-shifted to register-N, where it acts as a spin-period reference during the subsequent spin period. Each corresponding bit of counter-N′ and register-N feeds into a parallel-comparison gate (in the form of a "half-adder" or an "exclusive OR," depending upon the logic used). The outputs of these comparison gates feed into an n-input AND gate. Hence, each time that all corresponding bits in register-N and counter-N′ are at the same logical state, a coincidence pulse is produced at the AND gate output and counter-N′ is reset to zero. Since the input pulse rate to counter-N′ is f, the counter will repeat this cycle 2^m times during the time period T and will contain a remainder R at the commencement of the subsequent sun pulse.

The 2^m coincidence pulses which are generated during each spin period are separated from one another by exactly n/f seconds; hence, the pulse separation equality is limited only by the short-term

(continued overleaf)

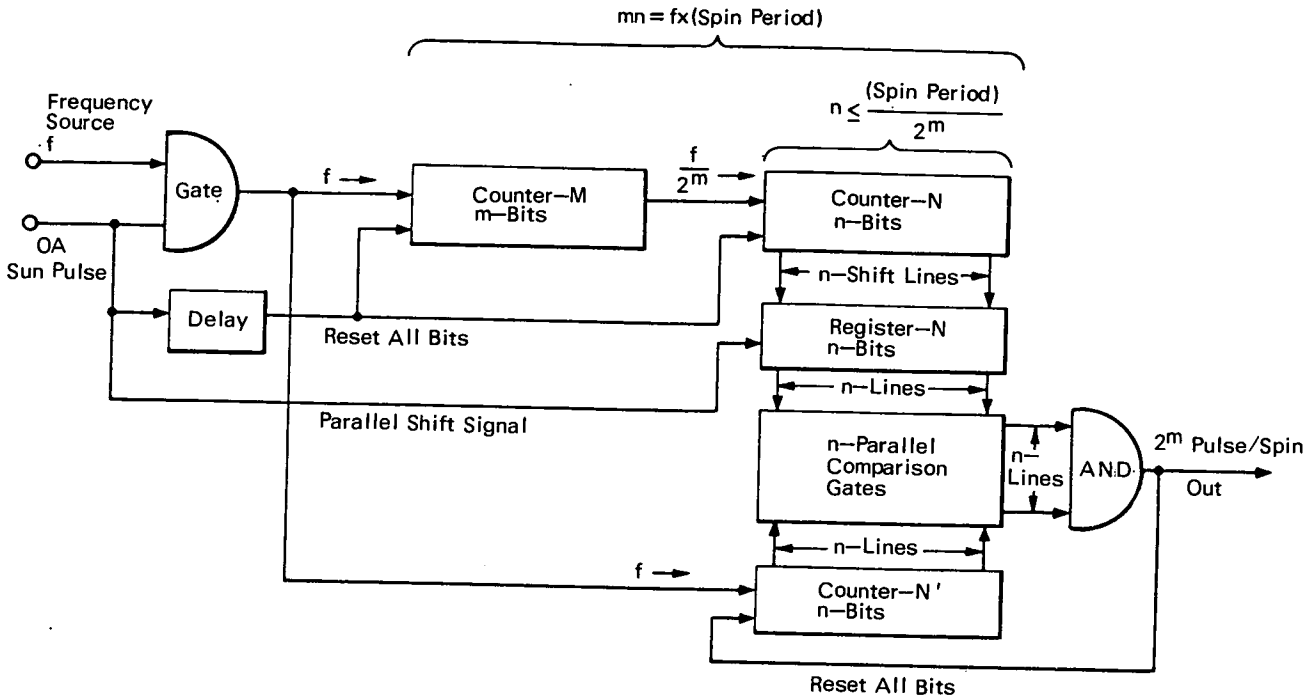

Figure 2. Circuit Block Diagram

stability of f. Any desired accuracy of equality in pulse separation may be achieved by crystal-controlling f and by the selection of f and n.

Notes:

1. The aspect clock flown on Pioneers VI, VII, and VIII is constructed from about 60 commercially available integrated circuits. The total weight is about 40 grams, and the clock requires 150 mW of regulated power
2. Accumulation time accuracy aboard Pioneer VI has been shown to be better than 2.5 parts in 10^5 during more than two and one-half years of continuous operation.
3. The form of the data obtained from the digital aspect system minimizes telemetry bandwidth requirements.
4. Requests for further information may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: TSP 71-10440

Patent status:

No patent action is contemplated by NASA.

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